Hazardous Waste Worker Labor Market Study

by

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January 2006

Produced for
The National Clearinghouse
for Worker Safety and Health Training
P.O. Box 65703
Washington, D.C. 20035

Funded by the National Institute of Environmental Health Sciences under Contract GS23F8091H

U.S. Department of Health and Human Services
National Institutes of Health
National Institute of Enviromental Health Sciences

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Hazardous Waste Worker Labor Demand

1. INTRODUCTION

This report is a study to update estimates of the demand for hazardous waste workers through 2010. The study was funded by the National Institute of Environmental Health Sciences' (NIEHS) Worker Education and Training Program (WETP) through a contract with the National Clearinghouse for Worker Safety and Health Training. One of the goals of this project is to update the employment estimates from an earlier study by the National Clearinghouse authored by Ruttenberg, 1996 and determine other, less resource-intensive, approaches for gathering this information. These labor demand updates are necessary to properly plan for the legally mandated health and safety training of hazardous waste workers. Congress funds government-sponsored hazardous waste work and other sources fund private sector work of this nature; thus, timely estimates of the demand for hazardous waste workers are essential. In addition, this study examines how innovative remediation technologies and methods possibly influence labor costs and the composition of the hazardous waste labor force.

Protecting the people who clean up hazardous waste and materials and who respond to emergencies involving hazardous substances is central to the mission of the National Institute of Environmental Health Sciences' (NIEHS) Worker Education and Training Program (WETP). Congress established this role as part of the Superfund Amendments and Reauthorization Act (SARA) of 1986. WETP has supported the development of occupational health and safety training courses for hazardous waste and emergency response workers, supervisors, and professionals that meet the requirements of the Occupational Safety and Health Administration's Hazardous Waste Operations and Emergency Response standard (HAZWOPER), which is the foundation upon which firefighters, emergency technicians, skilled support personnel, and cleanup workers are trained to respond to activities at uncontrolled hazardous waste sites. Since 1986, over 1,000,000 workers have received such training in 56,000 courses delivered nationwide.

This study of the demand for hazardous waste workers comes at a time when the industry is undergoing several major structural changes. As discussed in the following section, a shift is occurring from federally funded clean-up projects under the auspices of the Environmental Protection Agency (EPA) to projects directed by the Department of Energy (DOE) and Department of Defense (DOD) as well as by private sector, non-regulatory initiatives. Although significant amounts of military and nuclear waste sites remain contaminated and many Superfund sites are still awaiting remediation and removal, the push to work Brownfield sites is growing in different states and communities. This shift is discussed in the background section.

The technologies and methods used for clean-up have also been changing drastically. A major shift, with labor demand consequences, is from the historic "muck and truck" approaches of digging up, hauling, treating, and disposing of contaminated soils to the use of innovative technologies and approaches to treat the contaminants in the ground, so called "in situ" approaches. Noticeable shifts of skill requirements follow this transformation to less labor-intensive operations. This is because less manual labor is needed and a greater proportion of more skilled technical workers and equipment operators are employed; however, the requirements for safety and health training to protect workers who handle hazardous wastes still exist. Employers who comply with the regulations will need trained workers to perform hazardous waste clean-up activities.

The political climate at the state and federal levels has also changed, yielding a different attitude toward regulatory demands on businesses, especially regarding environmental issues. The central thrust is to leave such matters to market forces. The economy itself is undergoing changes under the continuing trends of deindustrialization, outsourcing, declining labor union density, further deregulation and privatization and a persistent devaluation of labor. Substantial immigration of foreign low-wage workers, predominantly from Mexico and Central America, is also occurring in different parts of the country. All of these factors play a role in determining both the demand for hazardous waste workers and the supply of a workforce with the necessary skills and proper training.

Projections of the hazardous waste workforce that will be needed in five and ten years vary considerably depending on models used; starting assumptions regarding costs, technologies and methods; labor mix; and other factors. Earlier labor demand estimates and projections, such as that done by Ruth Ruttenberg & Associates (RRA) in 1996, were based on assumptions about these factors that have changed noticeably. This report concludes that the projections made back then were high for several reasons, such as structural changes in the hazardous waste labor market, implementation of new technologies, and major shifts in government funding policies. Other labor estimates examined here are from the Department of Labor (DOL) and the Bureau of Labor Statistics (BLS). Of primary interest is the demand for workers engaged in physical clean-up activity or remediation and construction (R&C) work as well as operations and maintenance (O&M) work involved in ongoing projects. For example, R&C accounted for 35% of total remediation industry revenues in 1988, reached 60% by 1999, and is projected to climb to 66% by 2006.

The data used in the study are presented on charts and tables. Data sources are identified on the individual charts and tables. The employment data come mainly from the U.S. Department of Labor, Bureau of Labor Statistics that is referred to in the report as the BLS.

2. BACKGROUND

This Background section describes the context for this study of the hazardous waste work force. It provides a brief overview of the general economic environment in which employers in the industry have operated recently. This has a bearing on employment patterns and on labor demand in the immediate future.

A recent summary of the status of the environmental contracting industry reported in Engineering News-Record, July 5, 2004, showed that total revenue of the top 200 U.S. environmental contracting companies has been declining for two years in a row; down by 1.5% in 2002 from 2001, and down by 2.8% in 2003; for a net drop of 4.2% over two years. (See Table 1). The report indicates, however, that expectations are positive for a recovery of some degree in 2004. Nevertheless, a contraction of this industry has occurred. The impact this may have on hazardous waste worker employment is a major question. As of 2003, hazardous waste work accounted for 27.5% of total environmental contracting work and nuclear waste work accounted for 14.5%. Together, these represent the largest segment of environmental work at 42%. In addition, in 2003, $31.4 billion was generated in revenue by the top 200 environmental contractors, 33.3% of which came from private sector sources, 34.9% from federal programs, and 31.8% from state and local governmental sources. Data provided by Environmental Business International through the Environmental Business Journal, corroborated that significant revenues are generated in the site remediation market. The remediation/industrial services industry includes physical cleanup of contaminated sites, buildings, soil, groundwater, and operating facilities. Typical clients are government agencies, property owners, and industrial firms. (See Table 1).

Table 1.

Environmental Contract Work in 2003

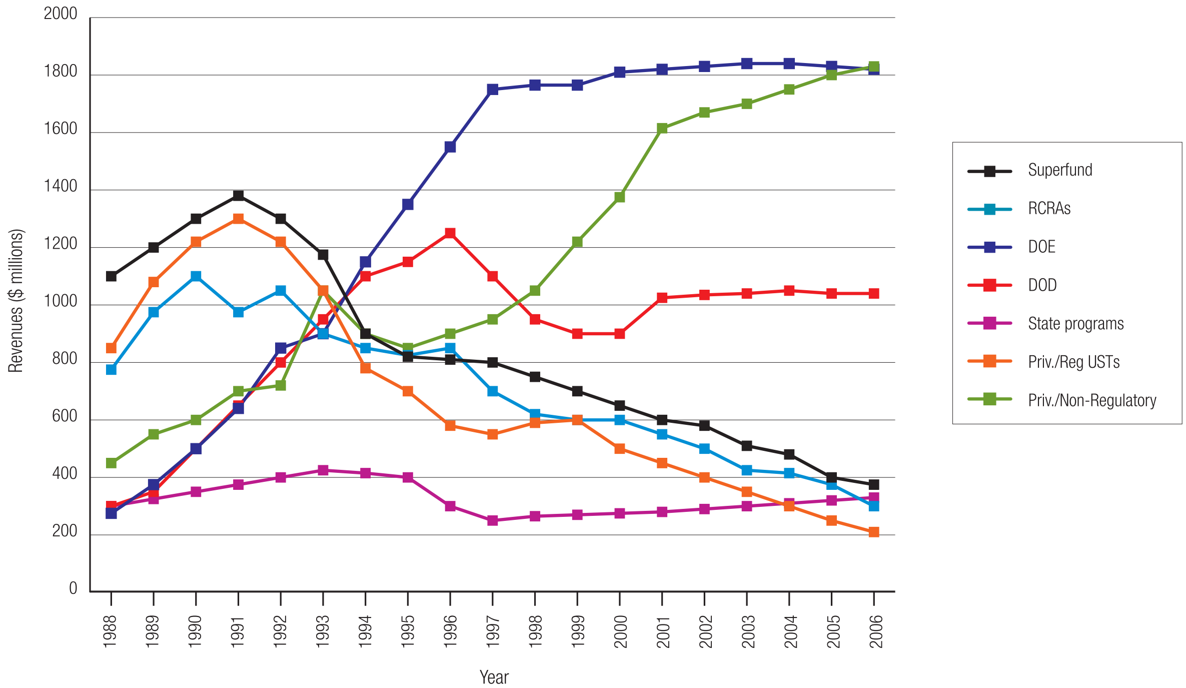
Type of work	Revenue in Millions	Share of Total (%)	Year	Total Revenue $ Millions	Change (%)
Hazardous Waste	8,624.5	27.5	2001	32.8	
Nuclear Waste	4,546.9	14.5	2002	32.3	-1.5
Water	6,016.8	19.2	2003	31.4	-2.8
Wastewater	6,525.8	20.8			
Air	958.5	3.1			
Environmental. Mgmt	2,016.1	6.4			
Environmental. Science	1,984.7	6.3			
Other	730.1	2.3			
Total	31,403.4	100.0			
Source of work					
Private	10,465.6	33.3			
Federal	10,964.1	34.9			
State/Local	9,974.1	31.8			
Total	31,403.8	100.0			

Source: Engineering News Record, "The Top 200 Environmental Firms," July 5, 2004.

In regards to site remediation revenues, Superfund, Resource Conservation and Recovery Act (RCRA) and Underground Storage Tank (UST) monies peaked at $1,400 million in 1990-91 but have fallen steadily and are projected to be well under half their original levels by 2006. The value of DOD work peaked at over $1,200 million in 1996 and then fell off to around $1,000 million by 1998 and remained fairly steady at that level. State program funds crossed $400 million by 1993 but have settled at about $300 million since then. The value of private non-regulated work climbed steadily to just under $1 billion by 1997 and is expected to grow rapidly to over $1.8 billion by 2006. Likewise DOE work has shot up significantly from nearly $300 million in1988 to almost $1,800 million in 1997 where it has held fairly constant. These trends are indicators of past and anticipated levels of business activity in the industry, as indicated in Figure 1. (Environmental Business Journal, Special Remediation Market Data Pack, *http://environmental-industry.com/ebj/specremmarda.html*).

Figure 1.

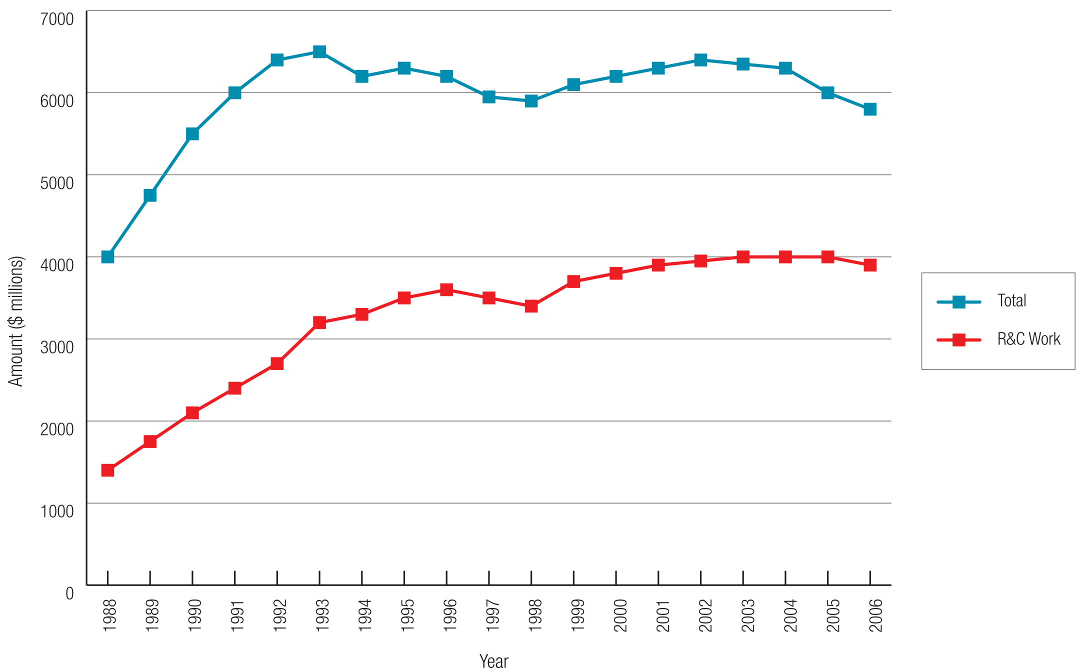
Site Remediation Market



The same data source also reports that for the same time period, total remediation revenues start at $4 billion and reach $6 billion by 1991 but remain nearly constant at or near that level thereafter. R&C revenues grow from an initial $1.4 billion to $4 billion by 2003, with growth slowing somewhat after 1993. R&C revenues are projected to hold at $4 billion through 2006 (see Figure 2).

Figure 2.

Remediation and Construction & Total Remediation Market Revenues



R&C accounted for 35% of total remediation industry revenues in 1988, reached 60% by 1999, and is projected to climb to 66% by 2006. This trend is a motivation to update hazardous waste labor estimates given R&C is the primary work category for what BLS classifies as hazardous waste production workers (see Figure 3). If growth in labor demand is at all proportional to growth in revenues (this has not been established but is a possibility if labor demand follows output), then the R&C employment growth rate should be similar to that on Figure 4. While generally increasing, the work increases at an ever-slowing rate, which is eventually expected to go slightly negative after 2004. This indicates a possible slow-down in demand for hazardous waste workers.

Figure 3.

Remediation & Construction Share Total

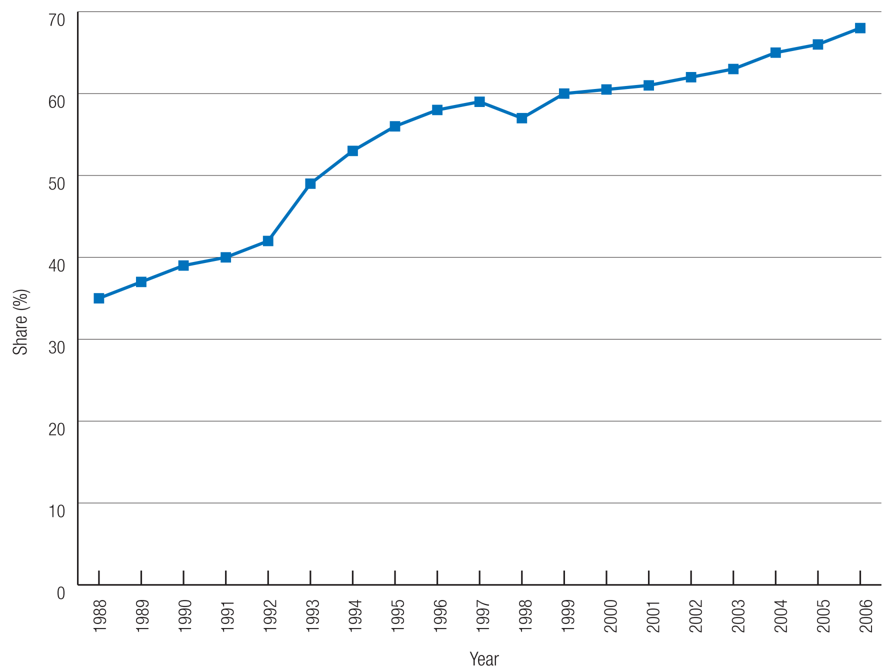
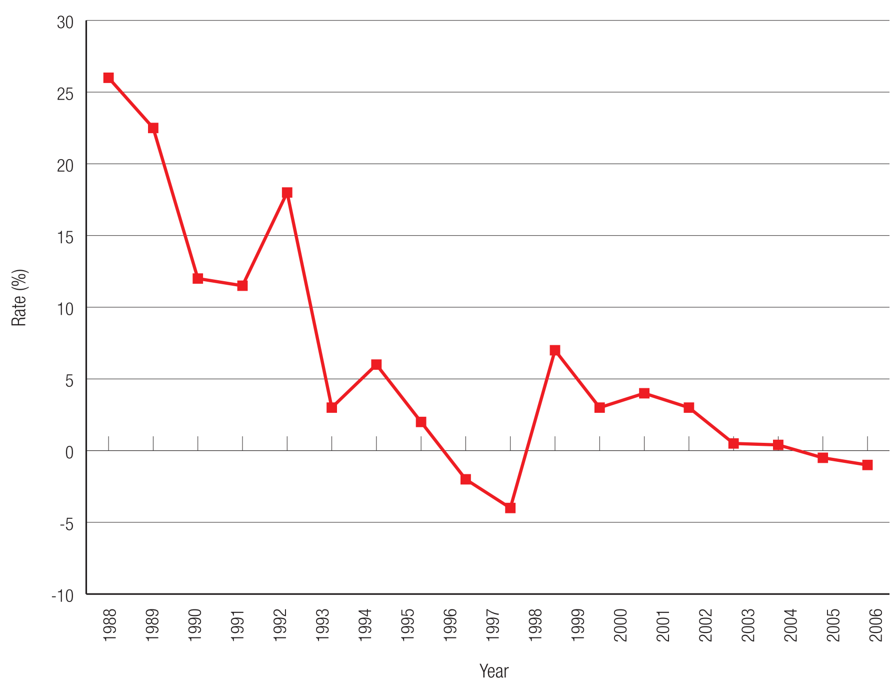


Figure 4.

Annual Rate of Growth, R&C Work - Measured by Growth in Revenues



Finally, additional evidence that EPA clean-up work is finishing is seen in the progress made on completing some NPL sites. Although the final stages of some Superfund projects are being reclassified to on-going projects, others have reached the stage of "construction completed." According to EPA data (Probst & Sherman, 2004, 2) from 1992 through 2000, an average of 77.3 sites per year reached this status. During 2001-2003, 43 sites per year were construction completed on average. This changes the demand for hazardous waste workers on NPL sites, as fewer workers are needed on some projects while others require more. The net effect is unclear.

3. HAZARDOUS WASTE EMPLOYMENT LEVELS

3.1 Current employment

The Bureau of Labor Statistics' (BLS) estimates of the number of hazardous waste workers are used as the main source of current employment information. The BLS data are fairly close to estimates provided by the Census Bureau from household interviews in the Current Population Survey (CPS) data. BLS data are taken from establishment payroll reports provided by employers through the Current Employment Survey (CES). Differences between the two are primarily due to CES not counting self-employed persons and others not on civilian payrolls, which are counted in the CPS.

The BLS' estimates for the annual number of hazardous waste production workers from 1994 through 2004 are shown in Figure 5. Production workers include employees below supervisory, managerial, and executive positions. Production job levels start at just over 76,000 and end at 76,100, reaching a maximum of 94,400 in 2001. The BLS estimates of hazardous waste treatment and disposal workers and remediation service workers are also shown in Figure 5. Among production workers, the number of remediation service workers has remained roughly the same since 2001 while the level of hazardous waste treatment and disposal workers declines noticeably. Currently, average employment in the former is at 26,700 and 49,400 in the latter. The total hazardous waste worker count given here is the sum of these two estimates. These are two of the three types of workers that comprise hazardous waste employment, according to the BLS. Data on the third type, hazardous waste collection workers are not provided separately by BLS (see Figure 5).

Figure 6 shows all employees - production, supervisory, and managerial - from 1994 through 2004. All categories grow on Figures 5 and 6 until 2001 and decline thereafter with production workers showing a sharper decline. The total employee count starts at 87,900 and ends at 101,700 reaching a peak of 111,500 in 2001. The drop in production workers after 2001 brings that job number almost back to its initial 1994 level while the number for all employees gains over 16,000, or more than 18%.

Figure 7 shows how the production worker count varies relative to total employees for the same time period. This ratio stabilized at just over 0.84 from 1996 through 2001, but fell to 0.777 by 2004. The change in the worker mix as indicated by this ratio may be reflecting the shift away from manual labor to more skilled workers due to technology changes occurring in the industry. Other less obvious factors may also be at play here.

Figure 5.

Hazardous Waste Production Workers

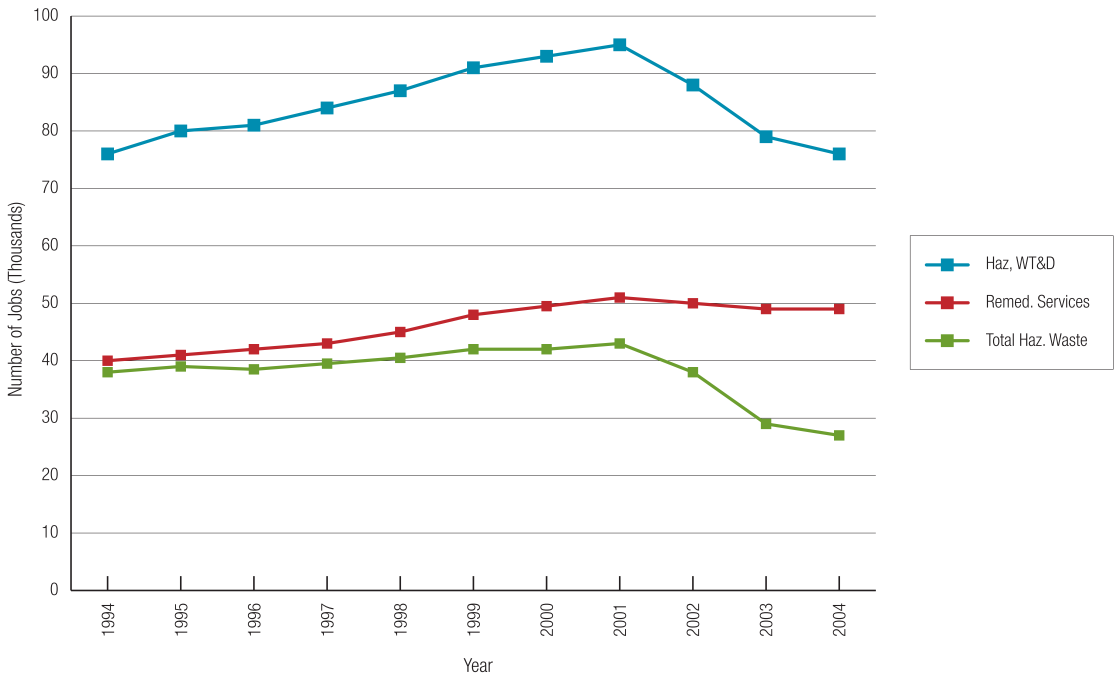


Figure 6.

Hazardous Waste Employment

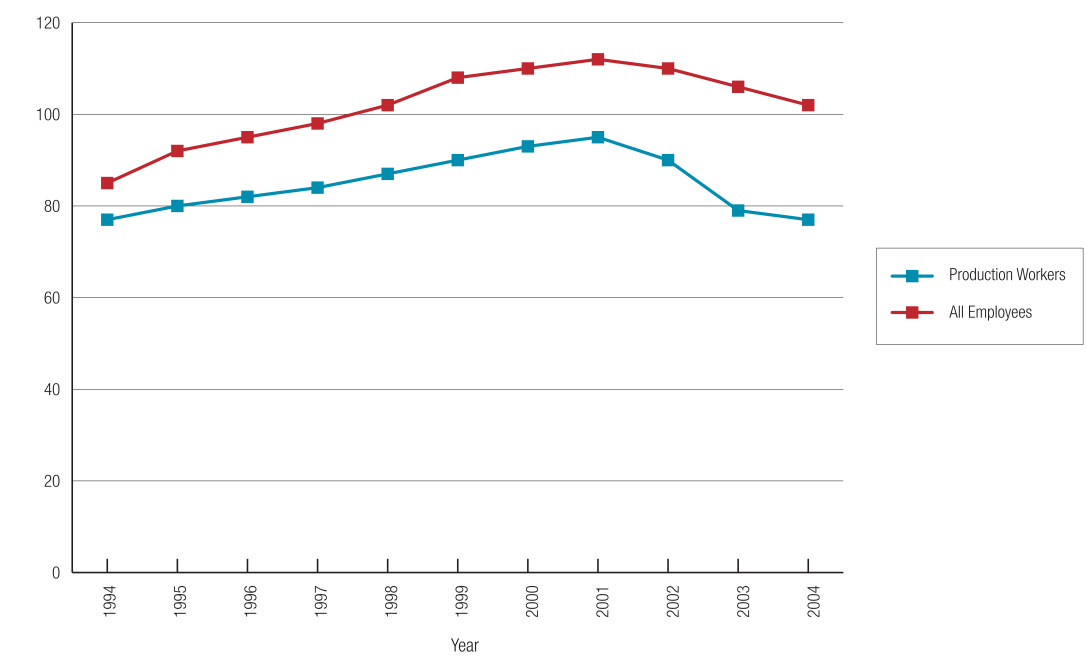


Figure 7.

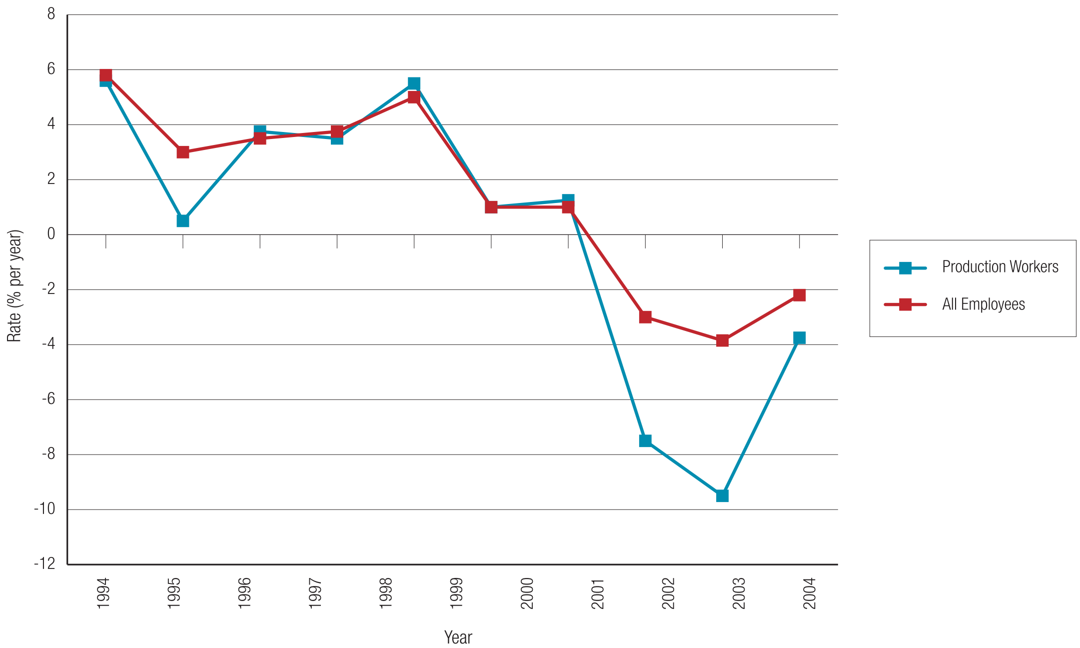
Hazardous Waste Worker Ratio, Production Workers to All Employees

Figure 8 shows the annual rate of change for the number of production workers and the number of all employees for the same time period. Both rates of change stabilized at about the same value from 1997 through 2001 but then fell off, with production numbers declining faster.

The growth of hazardous waste worker jobs in general slowed down after 1999 and declined after 2001. The annual growth rate was in the 0% to 6% range for both production workers and all employees from 1995 through 2001. Both growth rates went negative after 2001 with the production worker rate falling to almost -10%, and all employee rates to -4.0% by 2003 (see Figure 8).

Figure 8.

Hazardous Waste Worker Annual Growth Rates



Several concerns exist regarding these BLS employment numbers however. First, employment reports from general or prime contractors may include workers who are also reported on sub-contractor payrolls due to different and over-lapping record-keeping practices. This is a common problem in the construction industry. It can also be due to the actual work done by an individual worker falling in one skill category on one day of the week while in a different category on another day. Second, other contractors undercount the numbers of employees in their reports for various reasons including situations where improper payment of wages and/or benefits is made for various workers and reasons. This is more common with smaller employers and with non-governmental projects. Third, the type of work performed by an individual worker is not always consistently classified from one employer to the next and can vary widely in the course of a day or a week. This can result in miscounting over the course of a year when workers do several short-term jobs for different employers and on non-union projects where workers work across trade or skill lines. Finally, many remediation and clean-up jobs are short-term, well under twelve months, so annual employment figures such as these are averages at best. Thus, due to the nature of much of the hazardous waste work, employment counts in this industry should be regarded as estimates at best.

3.2 Projected employment

3.2.1 BLS projected demand for hazardous waste workers

The BLS projections for waste workers do not separate hazardous waste workers from the other types of waste workers. The projections are also for all employees; no estimates are provided for production workers. As a result, the two category total projections have to be scaled down to estimate the projected number of production workers and, with estimates for all employees and production workers, the two categories have to be scaled down to obtain hazardous waste worker projections.

The methodology for obtaining labor demand projections is simple and straightforward. Total projected jobs are given for the three categories: Waste Collection, Waste Treatment and Disposal (WT&D), and Waste Remediation and Other Services (WR&OS). As mentioned previously, this study is only interested in the last two categories, WT&D and WR&OS, given the lack of hazardous waste collection worker numbers from BLS. The projected total category numbers are 153,600 for the WT&D and 128,400 for WR&OS. This yields employment gains above 2002 levels of 34,000 and 32,100, respectively, from 2002 to 2012. WT&D jobs grow at an annual rate of change of 2.5% per year and WR&OS jobs at 2.9% per year, which are approximately the same rate (see Table 2).

In order to find the estimates of the number of hazardous waste workers in each of the two categories, the WT&D total is multiplied by the hazardous worker share of WT&D jobs (40.8%) and the WR&OS total is multiplied by the hazardous worker share of remediation jobs (63.1%). For year 2012, the projected number of Hazard WT&D jobs is 62,822 and the projected number of Hazard Remediation jobs is 81,020 (see Table 2).

Calculating the projections for production workers starts with the BLS total jobs for each category as well. This is multiplied first by the appropriate ratio of production workers to all employees for each category (0.856 for WT&D and 0.818 for WR&OS). This product for WT&D category is then multiplied by the hazardous production worker share of WT&D jobs (40.9%) and the WR&OS product is multiplied by the hazardous production worker share of remediation jobs (62.6%). The resulting production worker projection for Hazard WT&D jobs is 53,776 and is 65,750 for Hazard Remediation Jobs (see Table 2).

These above projections are based on the average hazardous waste worker share of respective category employment for all employees and for production workers. It is an employment weighted average of the annual share values. Higher than average share figures were observed between 1994 and 2003, as demonstrated in Figures 5 and 6 while the actual value for 2003 (after a two year decline in employment) was typically below this average. Thus the projected figures are indeed estimates, based on the most likely inputs available at this time. They are also subject to what actually happens in two major areas: (1) changes in remediation technology and methods which may lower the total hazardous waste labor requirement on some projects along with the shift in the employee skill mix required by the new technologies and methods, and (2) federal budget changes reflecting shifts in budget priorities for hazardous waste clean-up caused by changing political situations, both domestic and foreign.

Table 2.

Bureau of Labor Statistics Job Projections

Projected number of total jobs in 2012

	2002	20012	Gain	AARC*(% per year)	Net Chg(%)
Waste Collection	101,000	122,000	21,000	1.9	20.8
Waste Treatment & Disposal	119,600	153,600	34,000	2.5	28.4
Waste Remediation & Other Services	96,300	128,400	32,100	2.9	33.3
Total	316,900	404,000	87,100	2.5	27.5
Total w/o Waste Collection	215,900	282,000	66,100	2.7	30.6

Projected hazardous waste worker jobs in 2012

	2002	2012	Gain	AARC*(% per year)	Net Chg(%)
Number of jobs (All employees)					
Waste T&D		153,600			
Hazard WT&D share (%)		40.9			
Hazard WT&D jobs	46,700	62,822	16,122	3.0	34.5
Waste R&OS		128,400			
Hazardous WR&OS share (%)		63.1			
Hazard Remediation Jobs	61,500	81,020	19,520	2.8	31.7

Number of jobs (Production)

	2002	2012	Gain	AARC*(% per year)	Net Chg(%)
Waste T&D		153,600			
Prod./All Ees ratio (%)		85.6			
Hazard Waste Worker Share (%)**		40.9			
Hazard WT&D jobs	37,300	53,776	16,476	3.7	44.2
Waste R& OS		128,400			
Prod./All Ees ratio (%)		81.8			
Remediation Services Worker Share (%)**		62.6			
Hazard Remediation Jobs	50,100	65,750	15,650	2.8	31.2

* Compound average annual rate of change.

**Share of total category in hazardous waste work. Use weighted average share for 2012.

Source: BLS, Employment Projections, Employment & Output by Industry, Table 3, 6/24/04.

3.2.2 Laborers' Estimation Approach

Ken Allen, from the Laborer's West Coast Training facility, has developed a rough rule of thumb for estimating job levels. It is based on many years of experience with hazardous waste clean-up projects. He finds that, on average, 5 full-time jobs are created for every $1,000,000 of clean-up work, not counting DOD and DOE projects. Originally these were two laborers, two operators and one technician. Today, with newer technologies in the field, the mix is 1.5 laborers, 1.5 operators and two technicians. The craft mix is ignored at this point. This, however, provides a useful quick estimate of labor needs for non-DOD and non-DOE cleanup jobs.

3.3 Updating Employment and Labor Demand Projections

Subsequent to the initial release of this preliminary report, information from additional sources make it worthwhile to issue updates to the employment and labor demands projections of previous sections. Information from the EPA and the Government Accountability Project (GAP) provide new insight into hazardous waste clean-up costs while a recent report by John Gibbons presents both additional information on costs and labor demand estimates. These are discussed next.

Recent detailed data on hazardous waste clean-up expenditures are available from EPA (September, 2004) which provide a valuable single-source input on projected costs, for 2004 through 2033, and which reflects latest developments in hazardous waste remediation markets and technology. This data is summarized next on Table 3.

Table 3.

Hazardous Waste Clean-Up Costs & Sites (2004-2033)

Market Segment	Cost ($B)	Share of Total Cost (%)	Number of Sites	Share of Total Sites (%)	Average Cost per 1000 Sites($B)
RCRA	45	21.4	3,800	1.3	11.84
DOE	35	16.7	5,000	1.7	7.00
DOD	33	15.7	6,400	2.2	5.16
NPL (Superfund)	32	15.2	736	0.3	43.48
State & Private	30	14.3	150,000	51.0	0.20
Civilian agencies	19	9.0	3,000	1.0	6.33
UST	16	7.6	125,000	42.5	0.13
Total	210	100.0	293,936	100.0	0.71

NOTES:

RCRA is Resource Conservation & Recovery Act corrective action program; DOE is Dept.of Energy; DOD is Dept. of Defense; NPL is National Priority List; State & Private includes state mandatory, voluntary, and brownfields sites and private sites; civilian agencies are non-DOD, non-DOE federal agencies; UST is Underground Storage Tanks.

Cost and site data are average values based on a range of estimated values for each market segment.

Source: Author's analysis of data from EPA, Cleaning Up the Nation's Waste Sites: Markets & Technology Trends, 9/2004.

Table 3 shows cost and clean-up site information on federal, state and local government and private sector projects, grouped into seven major market segments. The data show $210 billion for projects on over a quarter million sites. The top four market segments listed in Table 3 account for 69.3% of costs. These are all federally funded clean-up programs and, according to the EPA, contribute to a majority of the funds that will be expended on hazardous waste clean-up for the next three decades. Over 90% of the clean-up sites fall into two market segments, state and private (which includes brownfields projects) with 51% and underground storage tanks (USTs) with 42.5%. While state and private projects and USTs account for 21.9% of costs, they are the lowest cost projects, on average, at $0.20 billion per 1,000 sites and $0.13 billion per 1,000 sites, respectively.

However, as is continually the case with public sector funded programs, actual expenditures as well as appropriations are subject to political considerations that alter funding levels from year to year. The GAO recently issued a report (GAO, 2005) on appropriations and expenditures of funds for Superfund projects, brownfields, and programs with the Agency for Toxic Substances & Disease Registry, and the National Institute of Environmental Health and Science. It is informative to observe how these expenditures fluctuate, absolutely and relative to appropriations, as this sheds light on one set of factors contributing to the complexities of projecting hazardous waste labor demand based on cost data.

Fluctuations over time include shifts in both the amounts appropriated and expended as well the ratio of the two. Analysis of the data from this GAO report from 1993 through 2005 show that, first, total appropriations for Superfund clean-up projects and the related programs have fluctuated moderately, falling by only $12 million (less than 1%) from $1,579 million in 1993 to 2005, while falling as low as $1,314 million in 1996 and climbing to $1,590 million in 2003. However, in real or constant dollar terms, total funding has fallen by 20.5% from 1993 through 2005.

Second, relative to total appropriations, total expenditures have followed a similar change pattern. Expenditures measure what was actually spent on clean-up programs and thus indicate in general what happens to labor demand. The current dollar value of expenditures fell by 7.9% over this period while constant dollar value dropped by 11.9%. The ratio of expenditures to appropriations went from 1.14 in 1993 to a low of 0.85 in 2000 and up to 1.05 by 2004. Thus expenditures go through a range of changes as well. Although hazardous waste clean-up costs involve much more than these EPA expenditures, as Table 3 shows, the data from this EPA report show the difficulty of making accurate labor demand projections based on project costs, even when they are accurately known.

Another source of information on clean-up liabilities of various remediation markets along with projections of employment and training needs is the recent report by John Gibbons. (Gibbons, 2004). The employment and training needs projections from that report are summarized next in Table 4. Gibbons only counts production workers, which corresponds to our concerns. Although we don't single out highway environmental work, he considers them part of the potential workforce. This is probably an overlap with state and private market segment from the EPA study. His range of estimates for remediation workers is 62,000 to 67,000; the annual training need, from 10,450 to 14,550; the median workforce is 64,500; and the median annual training need is 12,500. Thus his projected mean number of remediation workers of 64,500 compares well with the BLS-based projection of 65,750 from Table 2.

Table 4.

Hazardous Waste Worker Employment & Training Need Projections, 2005 - 2010

Remed. Market	Average Workforce Level	Estimated Turn-over Rate (%)	Annual Training Need	Median Workforce Level	Median Training Need
DOE	3,000 - 4,000	15 - 20	450-800	3,500	625
NRC	2,000 - 3,000	15 - 20	300-600	2,500	450
DOD	3,000 - 4,000	15 - 20	450-800	3,500	625
Superfund	8,000 - 10,000	15 - 20	1,200 - 2,000	9,000	1,600
Brownfields	2,000	20 - 25	400 - 500	2,000	450
Base Closure	3,000	15 - 20	450 - 600	3,000	525
Highways	31,000	20 - 25	6,200 - 7,750	31,000	6,975
Total Gov't	52,000 - 57,000		9,450 - 13,050	54,500	11,250
Private Sector	10,000	10-15	1,000 - 1,500	10,000	1,250
TOTAL	62,000 - 67,000		10,450 - 14,550	64,500	12,500

Source: John E. Gibbons, "Workforce Needs Assessment for Hazardous Waste Remediation and Related Environmental Remediation Markets", 9/04.

The Gibbons data can be used in an additional manner to utilize his technique of converting cost data into labor demand estimates. By working backwards, his labor demand figures can be divided into the appropriate cost figures for each market segment to yield a conversion factor (measured in $ Billion per 1,000 workers). Each of these factors can then be divided into the corresponding cost estimate for each market segment from the EPA report to determine what the EPA projected labor demand might be, based on the EPA costs.

Table 5 summarizes this effort. These conversion factors are essentially a rough estimate of labor productivity for the particular market segment. The output is the cost value and input is number of workers. Cost or expenditure involves much more than labor costs or even value added; hence the rough nature of this as a productivity measure. Nevertheless, the nature of the remediation work varies widely among sectors, as different types of remediation methods are required, a range of technologies are used, and different mixes of labor skills are involved. For example, NRC work is mainly clean-up of decommissioned nuclear reactors while DOD work includes extensive disarming of unexploded ordinance and the highways work involves basic road construction. Thus a wide range of productivity levels would be expected and, indeed, Table 5 shows just that.

Table 5.

Hazardous Waste Clean-up Conversion Factors

(Cost data is in $ Billions)

Gibbons' cost and labor demand data, 2005-10

Gov't Agency	Costs Min	Costs Max	Labor Demand Min	Labor Demand Max	Median Cost 2005-10	Median Labor Demand	Conversion Factor ($ Billion /1,000 workers)
DOE	35.0	40.0	3,000	4,000	37.5	3,500	10.71
NRC	3.0	4.0	2,000	3,000	3.5	2,500	1.40
DOD	6.8	6.8	3,000	4,000	6.8	3,500	1.94
Superfund	6.3	6.3	8,000	10,000	6.3	9,000	0.70
Brownfields	2.0	2.0	2,000	2,000	2.0	2,000	1.00
Base Closure	2.0	2.0	3,000	3,000	2.0	3,000	0.67
Highways	175.0	175.0	31,000	31,000	175.0	31,000	5.65
Total Gov't	230.1	236.1	52,000	57,000	233.1	54,500	4.28
Private Sector	8.0	10	10,000	10,000	9.0	10,000	0.90
TOTAL	238.1	246.1	62,000	67,000	242.1	64,500	3.75

NOTES:

Gibbons' cost data is also given along with labor demand data in his report.
Conversion Factor = Median Cost x 1000/Median Labor Demand.

Source: Author's analysis of data from Gibbons (2004).

Unfortunately, the proposed attempt to convert EPA cost data into labor demand values by aggregating different market segment costs from Gibbons' report to match the market segments and thus the costs from the EPA report proved unrealistic. It turned out that the drastically different market segment definitions in the two reports led to drastically different cost data which could not be realistically aggregated and compared. The initial objective of this effort in 2005 to update the projections from 2004 by using the new EPA cost data remains unfulfilled.

4. TECHNOLOGY COST EFFECTS

A major push has been underway in recent years to reduce the cost of hazardous waste clean-up activity. An important area of savings is with labor costs, by eliminating labor inputs or increasing labor productivity. Savings in capital costs are also sought which reduce initial costs of capital-intensive projects. Finally, reducing operation and maintenance costs reduces the long-term costs of projects of long duration. All of these alternatives can be realized by using current technology in different, more efficient ways or by utilizing advanced technology and also by improving the methods for performing clean-up work.

Different aspects of technology-based cost savings were investigated to fulfill the objective of this study to obtain remediation cost information for hazardous waste worker demand. The organizing of such an effort is aided by government agency-led efforts to structure a taxonomy for remediation technologies.

4.1 EPA technology classification scheme

The various federal government agencies involved in hazardous waste clean up have encouraged the development of a classification scheme for categorizing innovative technological developments. The U.S. Army Corps of Engineers (USACE) has an on-going effort in this direction. A broader effort is through the Federal Remediation Technology Roundtable (FRTR) (2001) which includes representatives of many federal agencies. The Environmental Protection Agency (EPA), a participant in FRTR, provides data on technology and on technology-driven cost savings based on the FRTR scheme.

EPA also issues a guide for documenting, managing, and using FRTR cost and performance information from remediation projects (EPA, 1998). Total remediation project costs, as viewed by FRTR, are broken into four component costs: 1) capital costs, 2) operation and maintenance (O&M) costs, 3) other technology-specific costs, and 4) other project costs. Labor costs are associated with the first three cost types as the cost of labor input (wages, salaries, and benefits). The FRTR defines labor costs in the first three components in the following manner:

1) Under capital costs, labor includes site work that involves "all work necessary to establish the physical infrastructure for a technology application and activities necessary to restore a site to pre-remediation conditions or to meet the specifications of a site restoration plan." They also include "construction or installation of remedial technology components and materials, including technology parts and supplies to make the technology and appurtenances operational..."
2) O&M costs include the costs of "labor to operate and maintain the technology and associated equipment, labor supervision, and payroll expenses. Covers ongoing operations, as well as preventive and corrective maintenance activities."
3) Other technology-specific costs contain labor costs in the costs of "activities associated with excavation, collection, or control of contaminated soil, sludge, and debris, prior to ex situ treatment, including staging of contaminated media. This element includes collection of drums containing contaminated media." EPA (1998:2-3, 2-4).

While explicit labor costs in O&M costs are obvious, the fees for labor in the other two cost components may be buried in the charges for contracting services for capital phase or other technology costs. In general, the problem of identifying labor costs has proven to be considerable.

The FRTR objective was to implement a reporting format that would, among other goals, (1) limit reported costs to just those that relate directly to the performance of a technology and to those items that would be useful in comparing unit costs (cost per unit of measure) between technologies and applications; (2) standardize cost data; and (3) allow compatibility with the reporting of project costs.

Samples of the desired cost reporting format are given in EPA (1998:2-13, 2-14) for a pump and treat system and an In Situ Enhanced Soil Mixing project. On both sample reports, labor is an explicit cost line under O&M costs.

Table 6, Technologies List, Innovative In Situ and Others, is a listing of innovative technologies and methods taken from the EPA's technology classification system. This list describes the basic innovative technologies looked at in the tables and discussions below.

Table 6.

Technologies List, Innovative *in situ* and Others

1. Activated carbon treatment (I)	14. *In situ* flushing (I)
2. Air sparging (I)	15. *In situ* thermal treatment (I)
3. Air stripping (I)	16. Mecha nical soil aeration
4. Bioremediation (I)	17. Monitored natural attenuation (MNA) (I)
5. Capping	18. Phytoremediation (I)
6. Chemical dehalogenation (I)	19. Pump & treat
7. Chemical oxidization	20. Soil vapor extraction (SVE)
8. Chemical treatment (see chemical oxidation, neutralization)	21. Soil washing (I)
9. Electro-kinetics (I)	22. Solidification/Stabilization
10. Excavation (includes physical separation)	23. Solvent extraction (I)
11. Filtration	24. Thermal desorption
12. Fracturing	25. Treatment barriers (permeable reactive barriers) (I)
13. Incineration	26. Vitrification (I)

Sources: EPA, *Citizens Guide Series*, EPA 542-F-01-001 through 022; April 2001 & 2002.
EPA, "Annual Status Report: Treatment Technologies for Site Cleanup", 11th edition, EPA-542-R-03009, February 2004.

Table 7 lists different technologies employed in Superfund site remediation according to frequency of use, from 1982 through 2002. The table only lists those technologies with a frequency of 5% or more of the actions in each category. Technologies are listed according to major classifications by control mechanism utilized. Those technologies and methods listed in Table 7 for Ex Situ Source Control account for 76.5% of applications, those in In Situ Source Control, for 71.7%, and In Situ Groundwater, for 81.0%. Pump and Treat methods account for 100% of Ex Situ Groundwater applications. By this method, some of the major Superfund remedial technologies are identified on Table 7.

Table 7.

Top Technologies In Superfund Remedial Actions - From 1982 through 2002

Source Control, *Ex Situ* [12% used after 1999]	# Uses	Share (%)
Solidification/Stabilization	157	31.5
Incineration (off site)	104	20.8
Thermal desorption	69	13.8
Bioremediation	54	10.8
Incineration (on site)	43	8.6
Source Control, *In Situ* [14% used after 1999]		
Soil vapor extraction	213	58.5
Bioremediation	48	13.2
Solidification/Stabilization	48	13.2
Groundwater, *In Situ* [39% used after 1999]		
Air sparging	58	34.3
Bioremediation	44	26.0
Chemical treatment	21	12.4
Permeable reactive barrier	17	10.1
Multi-phase extraction	14	8.3
Groundwater, *Ex Situ*		
Pump & treat	743	100.0

NOTE: Technologies shown account for 5% or more of the actions in the control category.

Source: EPA, *Treatment Technologies for Site Cleanups, Annual Status Report*, (11th edition), 2/04: Appendix A.

4.2 Innovative technology improvements

Table 8 lists innovative In Situ technologies used by the number of sites in an EPA study and the cost savings realized by using the specific technology on given clean-up sites. Of the $2,644 million in savings, for example, soil vapor extraction accounted for 47.2% of the savings and generated an average savings of $35 million per site. On the other hand, vitrification generated $82 million per site, the largest average savings per site, but was used in only 6.2% of sites observed.

Additionally, Table 8 shows the share of innovative In Situ technologies used in contracts. The most frequent is soil vapor extraction with 29%, the next frequent is bioremediation with 22%, then stabilization/solidification with 20%.

Table 8.

Cost Savings by Technology Type - Innovative In Situ Technology

	# Sites	Savings (Millions, 2000 $)	Average Savings per Site ($ M)	Share of Savings (%)
Soil vapor extraction	36	1,248	35	47.2
Bioremediation	26	517	20	19.6
Thermal desorption	15	158	11	6.0
Air sparging	8	74	9	2.8
Phytoremediation	5	18	4	0.7
Treatment barrier	4	58	15	2.2
Solvent extraction	2	125	63	4.7
Vitrification	2	164	82	6.2
Other	10	282	28	10.7
Total	108	2,644	24	100.0

Source: EPA, ORD, FY 2001 SITE Report.

Contracts Awarded By Technology Type, Fy2001

Type	Share (%)
Soil vapor extraction	29
Bioremediation	22
Stabilization/Solidification	20
Chemical treatment	10
Filtration	7
Soil washing	2
Solvent extraction	2
Oxidation	2
Vitrification	2
Thermal desorption	2
Electro-chemical	1
Other	1
Total	100

To generate detailed cost information according to type of technology, different FRTR Cost and Performance case study reports are examined and summarized in the next section.

4.3 Review of FRTR Cost and Performance Reports of various case studies

In an attempt to obtain labor costs that reflect various labor demand features of different technologies and treatments, a review was made of 222 case studies provided by Federal Remediation Technology Roundtable as of 2001. The FRTR data that was reviewed consisted of cost and performance reports from various EPA remediation projects as far back as 1990. The technologies were broken down according to the innovative technology listings presented on Table 6. The FRTR Case Study Review Summary shows the technologies and treatments included in the case studies and summarizes them by frequency of application and share of total cases. The seven most frequently used technologies accounted for over 65% of the cases reported, with Pump & Treat methods used most frequently (19% of the cases).

The cost portion of the cost and performance reports were examined and available cost data recorded with pertinent descriptive data about each case, as well as the available cost information. After detailed review of the case studies, only 27 out of the total of 222, or 12.2% of the cases, were found to have labor cost data included in the cost and performance reports. Average labor costs are determined for the few technologies for which labor costs are available. These are summarized below. However, there are not adequate details provided in the case study reports to set any useful analyses of these labor costs in ways that would provide an indication of labor demand, either by labor hours or employment levels of skill mix to go along with the technology distinctions (see Table 9.).

Table 9.

Average Labor Cost

Physical Separation, SGS (4)	$73,599
Incineration (2)	$625,000
In Situ Thermal Treatment (2)	$1,443,500
P&T (8)	$746,971
Thermal Desorption (4)	$281,835
Soil Vapor Extraction (2)	$276,900

The dollar amount is the average cost for the technologies and treatments listed. Other technologies appeared only once in the review with labor costs and hence could not provide a realistic average. The number in parentheses is the number of times this technology was reported with labor costs and it therefore represents the number of cases used to determine the average. Beside the small sample size on which these averages are based, there are insufficient data to analyze or qualify these values other than to identify the technology or treatment involved.

Despite the efforts made by FRTR to standardize cost and performance reports, there is a lot to be desired regarding compliance with the report format. This review shows that cost data in the case studies reviewed are entered in a wide range of formats, with much missing data. Lack of availability to adequate information prevents any further meaningful conclusions beyond the average costs just listed.

5. FINDINGS

5.1 Labor demand projections

The results from Section 3.2 provide estimates of hazardous waste employee numbers. These are based on BLS data and were shown on Table 2 in that section. The pertinent information is summarized below on Table 10.

Table10.

Hazardous Waste Worker Demand Projections

		Projected number in 2012	Increase from 2002
All employees			
	Hazardous waste treatment & disposal	62,822	16,122
	Remediation work	81,020	19,520
Production workers			
	Hazardous waste treatment & disposal	53,776	16,476
	Remediation work	65,750	15,650

Note: Any hazardous waste employment in Waste Collection is not included here.

5.2 Status of the cost-based approach

Projections for hazardous waste worker demand from the Ruttenberg study depended, among other factors, on anticipated expenditures for various clean-up tasks. The total cost numbers assumed in the model are questionable today. Table 11, which is a copy of Table 15 from the RRA study (Ruttenberg, 1996, 59), gives the assumed cost values used in that study. These estimates are inflation-adjusted values. The total cost for hazardous waste clean up from 1990 to 2010 is $758 billion, which is very high compared with estimates examined next. NPL costs alone are listed as $155 billion.

To put these assumed costs in perspective, consider the following:

1) Total Superfund costs, inflation adjusted, from 1999 through 2009 are projected by K. Probst et al (see Probst, 2001: 12 and 160) to be $18,388 million. Doubling this amount to roughly compare with the RRA time period yields only $36,776 million for Superfund clean-up costs.

2) EPA appropriations from 1998 through 2004 total $55,627 million (EPA, 2004). Scaling this figure to 20 years to compare with the RRA time period gives a gross (and overly conservative) estimate of the entire EPA appropriation for 20 years as $158.9 billion.

3) Using the data on Figure 1 for the site remediation market revenues from 1988 through 2006, the total amount comes to $112,875 million. Again, scaling this total to twenty years gives a gross total revenue in that industry of $125.4 billion. If the revenue received by firms in the site remediation business is any measure of what was spent in that industry, then direct expenses by the funding sources listed on Figure 1 would be in the range of $125.4 billion. These sources are comparable to the RRA six site categories for clean-up work funding.

In light of these three cost comparisons, the conclusion is that the total cost assumptions from 1994-96 used in the RRA model turned out to be too high. For political and other reasons, expenditures since then fell well below the assumed levels. Thus, the projected employment levels are correspondingly too high since employment depends directly on total cost in the RRA model. Changes in other factors, such as technologies and methods and the resulting labor mix, also had an impact on projections. The impacts of these effects are more complicated to evaluate.

An effort was made to collect data from the sources involved to update the Ruttenberg model with more accurate total cost values. This turns out to be an extremely difficult task, stemming primarily from the unavailability of total clean-up cost data from the agencies involved and from the state and private sector. Various agencies provide reports of clean-up projects, such as the Federal Remediation Technology Roundtable cost and performance reports used in the case study review discussed above in Section 4. However, as discussed, the format of such reports, and therefore the manner in which costs are reported, vary to such an extent that consistent results are nearly impossible. This makes obtaining usable cost data rather impossible as well.

This problem with obtaining adequate cost data has been confirmed in informal conversations with James Platner of the Center to Protect Workers Rights; David Meadows from the Huntington, WV, office of the U.S. Army Corps of Engineers; and Kate Probst, from Resources for the Future. This indicates a need for approaches other than the cost-based models to determine projections of the labor demand for hazardous waste workers.

Table 11.

Billions of Dollars That Have Been and Will Be Spent on Various Categories of Hazardous Waste Cleanup - 1990-2010

Site Category	1990-1995	1996-2000	2001-2005	2006-2010	Total
NPL	$19	$30	$60	$46	$155
RCRA	$49	$100	$130	$96	$375
DOE	$9	$30	$40	$20	$99
DOD	$7	$12	$3	$2	$24
UST	$27	$6	$3	$3	$39
State/Private	$4	$13	$27	$35	$79
TOTAL	$113	$191	$252	$202	$758

From Ruttenberg, 1996, Table 15.

5.3 Alternative approaches for estimating labor demand

At least three alternative approaches exist which can be explored for estimating the demand for hazardous waste workers.

1) Contacting hazardous waste contractors and/or contractor associations to obtain either labor cost information or actual labor demand estimates. Records of completed clean-up projects contain initial estimates that include labor time and costs. David Meadows, from the USACE, provided information on sources of such information, including three software packages and related databases. Meadows has also supplied additional information that could be used to follow up with contractors and to access USACE clean-up project data records, subject to official approval for doing so. Both Ken Allen and Kate Probst also recommended seeking information from contractors and provided contacts for doing so.

2) Jim Platner, from the Center to Protect Workers Rights, suggested a work sampling approach to obtain information that could be used to determine labor demand for hazardous waste workers. Work sampling is an old technique based in the science of industrial work measurement.

3) It is also possible to determine labor demand from labor productivity data. Once projected output is available along with productivity (in output per hour of labor time), then labor time and numbers of employees can be determined. This approach would require contacting contractors to obtain appropriate data and could also come from work sampling.

The selection of alternatives will require planning and development of the exact method to be employed. In addition, the cooperation of supportive contractors will be essential, regardless of which alternatives may be implemented. This will require adequate preparation and networking to develop a list of contractors, with their contacts, who will be willing to participate in the alternative approach.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1) Obtaining realistic projections of hazardous waste workers is still a legitimate effort in light of the continuing need, albeit different from the past, for workers in this industry. The challenge is to obtain adequate information to make such projections. In view of this, projections based on BLS data are the most convenient and are supported by other studies.

2) Attempting to up-date studies based on cost data is difficult as many obstacles exist to obtaining reliable cost information, in particular labor cost data, for hazardous waste clean-up projects.

3) Alternatives exist for providing these estimates that avoid the cost problems, although they pose difficulties of their own. These options merit careful examination as alternatives to the earlier cost methods.

6.2 Recommendations

1) Develop a labor demand-technology matrix, to the extent possible, which would provide a connection between types of remediation technologies and methods and labor requirements, by number and type (skill or craft) of worker. This would require finishing and possibly expanding the FRTR case study cost analysis. This would provide a way to estimate future labor needs given the technologies to be employed. As new technologies/methods come on line, the matrix would be expanded to incorporate the new entries. This would also require monitoring the ongoing work of the FRTR and similar groups to stay current on their activities with remediation technologies.

2) Develop a work sampling system to obtain labor demand information from actual projects, either through inspection of available records (as with USACE records) or from contractor supplied data. The findings would be classified by technology/methods and conditions of application. Then a generalization of labor needs would be made by extension of the findings by type of projects sampled to overall expected work of that same type. A probable component of this project would be accessing useful USACE databases with the appropriate software.

3) Set up and implement a scheme to contact cooperative contractors to obtain labor demand estimates. If the total cost analysis approach is abandoned, then cost data as such is no longer needed. Actual labor demand estimates are what would be needed along with productivity data, if available, from contractors. This could be done in conjunction with (1) and/or (2).

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